Crossing experiments with *Bombus terrestris terrestris* (LINNAEUS, 1758) and *Bombus terrestris xanthopus* KRIECHBAUMER, 1870 and some notes on diapause and nosemose (Hymenoptera : Apoidea)

by

Roland DE JONGHE

Abstract. Colonies of *Bombus terrestris terrestris* and *B. terrestris xanthopus* were reared in captivity and copulations were observed between *terrestris* females and *xanthopus* males and vice versa and between the F1-generation females with *terrestris* or *xanthopus* or F1-generation males. There was no limitation in fertility. Some observations on the fysiology of *xanthopus* are reported : an exceptional susceptibility to nosemose and the tendency of the females to a short diapause.

Samenvatting. Kruisingsexperimenten met *Bombus terrestris terrestris* (LINNAEUS, 1758) en *Bombus terrestris xanthopus* KRIECHBAUMER, 1870 en enkele bemerkingen over diapause en nosemose (Hymenoptera : Apoidea). Kolonies van *Bombus terrestris terrestris* en *B. terrestris xanthopus* werden in gevangenschap gekweekt en paringen werden waargenomen tussen *terrestris*-koninginnen en *xanthopus*-mannetjes en omgekeerd en tussen de F1-koninginnen met *terrestris*- of *xanthopus*- of F1-mannetjes. Er was geen beperking in de vruchtbaarheid. Enkele waarnemingen over de fysiologie van *xanthopus* worden meegedeeld : een uitzonderlijke gevoeligheid voor nosemose en de korte diapause bij de koninginnen.

Résumé. Expériments d'hybridation avec *Bombus terrestris terrestris* (LINNAEUS, 1758) et *Bombus terrestris xanthopus* KRIECHBAUMER, 1870 et quelques notes sur la diapause et la nosemose (Hymenoptera : Apoidea). Des colonies de *Bombus terrestris terrestris* et *B. terrestris xanthopus* étaient élevées en captivité et des copulations entre *terrestris* reines et *xanthopus* mâles et vice versa étaient observées, ainsi qu'entre les F1-reines et les mâles de *terrestris* ou de *xanthopus* ou de la F1-génération. Il n'y avait pas de limitation dans la fertilité. Quelques observations sur la physiologie de *xanthopus* sont rapportées : une susceptibilité exceptionelle pour la nosemose et une tendence des reines vers une diapause de courte durée.

Introduction

The long time isolation of the island Corsica pushed the bumblebee population there in a divergent development from that of the continent. For example, the *xanthopus* taxon is not only different in coat colour, but also morphological (e.g. punctuation in the ocellar field) and enzymological differences exist (KRUEGER, 1951; P. RASMONT, pers. comm.; A. SCHOLL, pers. comm.). The aim of these experiments is to test if a reproductif barrier is already established between the two taxa.

Material and methods

Nestseeking *xanthopus* females were caught at Renno, Corsica on 27-V-1983 and at Calenzana, Forêt de Bonifatu on 26-V-1982. Some *terrestris* females were taken at Wassen (Gotthartpass, Switzerland) while foraging on willow on 9-IV-1983. A few more females were taken from a nest (Westerlo, Belgium, July 1983) containing numerous female pupae. Individuals belonging to the same colonies as the actual females and males were examined morphologically by Ing. agr. P. RASMONT (Faculté des Sciences agronomiques de l'État, Gembloux, Belgium) and enzymologically by Prof. Dr. A.

SCHOLL (Zoologisches Institut der Universität Bern, Switzerland) and identified as *Bombus terrestris terrestris* or *Bombus terrestris xanthopus*. For methods of rearing and hibernation see DE JONGHE (1982) and DE JONGHE & RASMONT (1983). In addition some females were given the possibility to initiate a nest in a natural way in a nestbox provided with upholsterers cotton and connected with a cage with flowering plants. In addition some established nests were put in a heated transparant box, with access to the open air.

Results and discussion

The results presented in table 1 show an unlimited fertility between *B. terrestris terrestris* and *B. terrestris xanthopus* and between their offspring. Untill further morphological, enzymological or other research should reveal more differences, these bumblebee taxa should still be regarded as races as it is the case now (RASMONT, 1983). The haircoat colour of the hybrid offspring (which will be described in a later paper) resembles very much that of certain *terrestris*-forms occurring on the Isle of Elba, where typical *terrestris* and *xanthopus* fly together with intermediate forms (RASMONT, pers. comm.). This can be explained as a natural hybridation.

no of nest	type of crossing	production of workers	females	males
83-54	*xant.* ♀ x *terr.* ♂	x	-	x
84-2	"	x	x	x
84-3	"	x	x	x
84-6	"	-	-	x
84-18	"	x	-	-
84-19	"	x	x	x
84-20	"	x	x	x
84-24	"	x	x	x
84-30	"	x	x	x
84-31	*terr.* ♀ x *xant.* ♂	x	-	x
84-32	"	x	-	x
84-37	"	x	-	-
83-52	"	x	-	x
84-45	(*xant.* x *terr.*) ♀ x *terr.* ♂	x	x	x
84-46	"	-	-	x
84-56	"	x	x	x
84-42	(*xant.* x *terr.*) ♀ x (*xant.* x *terr.*) ♂	-	-	x
84-51	"	x	-	x
84-52	"	x	x	x

Table 1. Offspring of matings between *B. terrestris terrestris* (LINNAEUS, 1758) and *B. terrestris xanthopus* KRIECHBAUMER, 1870 and their hybrids.

Some biological remarks

High susceptibility to nosemose

The high susceptibility of *xanthopus* and his hybrids to nosema disease was very remarkable. During many years of rearing bumblebee colonies, I

never observed clinical cases. Typical *terrestris* and other bumblebee colonies, reared at the same time and under the same conditions were clinically in good health. In infected colonies, workers, males as well as females could be ill, not only in winter rearings (when a lack of fresh pollen could be responsible for a decreased resistance), but also in summer with a daily supply of fresh pollen.

The symptoms were distended abdomen (sometimes telescope-like), paralysis of wings, legs, proboscis, and diarrhoea. Moreover and very distressing in this kind of experiments : a complete lack of sexual attraction and hence absence of copulation. Microscopic examination of squeezed intestine showed a mass infection with *Nosema* sp. spores. Moreover many flagellates were moving, but it is uncertain if they were pathogenic.

Treatment of already infected colonies with Fumidil B was not successfull. However, preventif administration precluded clinical outbreaks. By now I apply Fumidil B in the sucrose solution permanently (500 mg commercial Fumidil B soluted in 1 l of a 40% sucrose solution). So far no negative effect of this treatment could be observed.

The question arises : could a possible absence of *Nosema bombi* in Corsica cause an innate lower resistance to that disease, or is it the presence of another strain of *Nosema* sp.?

Tendency to a short diapause

Four tests of hibernation in soil were carried out : three in cages with a bottom of a sand-peat mixture, one in a flying cage (4 x 4 x 4 m) with a natural soil with a variety of barren and plant covered surfaces and slopes. Table 2 gives the data of hibernation of 56 females. After the latest date of apparition, all females had finished their hibernation. The mean duration of diapause takes 125 days. This is roughly half the time required by temperate European bumblebees (estimated 210-260 days). Another important fact is the spreading of the apparition over all months of the diapause. This corresponds with observations in Corsica, where *xanthopus* is flying practically the year round (FERTON, 1901).

The maximum day temperature in December, January or February was often not rising above 4-8°C. A response to an increased temperature could thus be excluded. I had the impression that rainfall stimulated the leaving of the hibernacula. This too corresponds with observations in Corsica.

Females of other species (races) (*Bombus terrestris terrestris* (LINNAEUS, 1758), *B. magnus flavoscutellaris* G. & W. TRAUTMANN, 1915, *B. cryptarum* (FABRICIUS, 1776), *B. lucorum* (LINNAEUS, 1761) and *B. jonellus* (KIRBY, 1802), hibernating under the same conditions, remained in the soil till March or April. As can be seen in tabel 2, also the hybrid offspring ((*terrestris* x *xanthopus*)F1 female) had a shortened diapause. The tendency to a short diapause seems to be genetically fixed.

Table 2. Dates and duration of diapause of *xanthopus* and (*terrestris* x *xanthopus*)F1-females in captivity.

Test 1. Diapause of 15 *xanthopus* females in a cage with soil of sand/peat mixture.

Date of entering diapause	Number of females	Date of ending diapause	Approximate duration of diapause (in days)
28-VIII-1983 till	1	27-X-1983	54
10-IX-1983	1	5-XI-1983	63
appr. 3-IX-1983 (*)	2	22-XII-1983	110
	6	24-XII-1983	112
	2	30-XII-1983	118
	1	4-11-1984	154
	2	5-11-1984	155
	15		114 (mean)

Test 2. Diapause of 10 *xanthopus* females in a cage with soil of sand/peat mixture.

Date of entering diapause	Number of females	Date of ending diapause	Approcimate duration of diapause (in days)
5-IX-1983 till	1	25-X-1983	43
20-IX-1983	4	19-1-1984	129
appr. 12-IX-1983 (*)	1	5-11-1984	146
	1	7-11-1984	148
	1	11-11-1984	152
	2	18-11-1984	159 (**)
	10		132 (mean)

Test 3. Diapause of 5 (*terrestris* x *xanthopus*)F1-females in a cage with soil of sand/peat mixture.

Date of entering diapause	Number of females	Date of ending diapause	Approximate duration of diapause (in days)
appr. 7-VIII-1983 (*)	1	27-VIII-1983	20
	1	17-IX-1983	41
	1	31-XII-1983	145
	2	22-III-1984	228 (**)
	5		132 (mean)

(*) : As the females were not marked, individual entering or ending diapause could not be observed. Therefore, the dates are approximatif.

(**): These females were dug up by myself. They were the last ones in their hibernacula. They are considered here as if they were appeared spontaneously.

Test 4. Diapause of 26 *xanthopus* females in a flying cage with natural soil.

Date of entering diapause	Number of females	Date of ending diapause	Approximate duration of diapause (in days)
appr. 1-VIII-1982	1	14-X-1982	74
	1	17-X-1982	77
	1	25-X-1982	85
	1	4-XI-1982	95
	6	6-XI-1982	97
	1	7-XI-1982	98
	2	9-XI-1982	100
	1	10-XI-1982	101
	1	5-XII-1982	126
	4	19-XII-1982	140
	4	16-I-1983	168
	1	12-II-1983	195
	1	21-II-1983	204
	1	11-III-1983	222
	26		127 (mean)

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De Jonghe, R.: Langstraat 105, B-3180 Westerlo (Belgium)